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(54) **Apparatus for the processing of granular material**

(57) A foundry sand preparation apparatus includes a receptacle into which is fed sand to be processed. The temperature and moisture content of the sand being fed in is monitored by sensors. Signals from these sensors are used to control the quantity of water sprayed into or within the receptacle wherein meshing mixers mix the water and sand. The level of the sand in the receptacle is monitored and a signal is produced to control the speed of a belt conveyor which removes processed sand from the bottom of the receptacle, the level also being used to influence water input rate.

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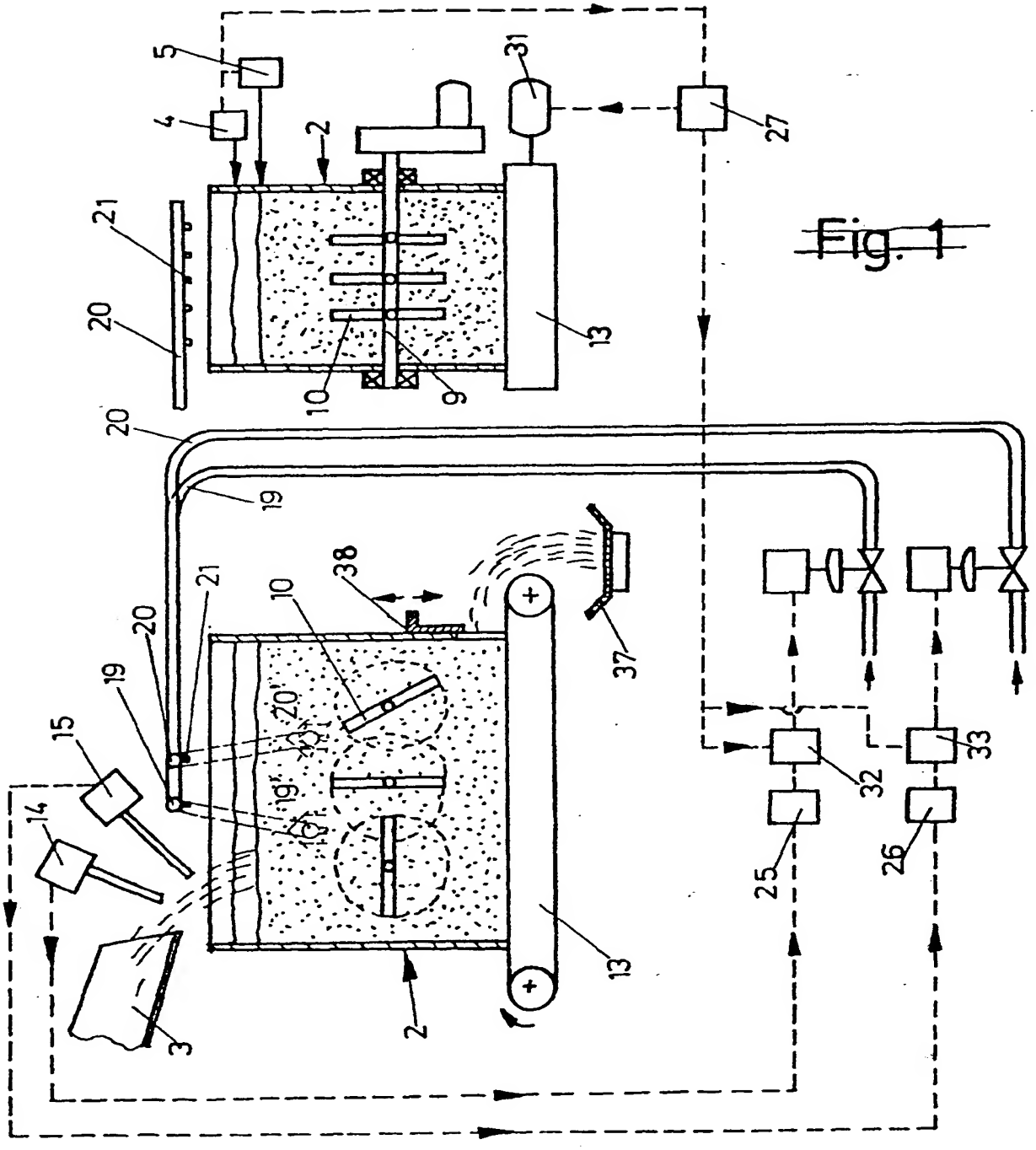
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3

Fig. 1

SPECIFICATION

Apparatus for the processing of granular material

This invention relates to an apparatus for the preparation of granular material, particularly foundry mold sand, so that the processed material has predetermined moisture characteristics.

The prior art includes many different types of devices intended for the preparation of foundry mold sands. The sand collected from the unpacking point must be cooled, be free of lumps, and must have a certain degree of moisture at room temperature in order to be suitable for re-use. Also, certain additives, for example clays, must be mixed therein.

Swiss patent 402, 293 shows an apparatus which includes an inclined mixing drum, the angle of which is adjustable, for sand at higher temperatures and which is continuously speed-adjustable (without stages). A conveyor belt conveys sand continuously into an open side of the drum which opens upwardly. The sand is thoroughly mixed by rotation of the drum. A water input conduit projects into the drum. A separate cooling device is series-connected to the drum. Good mixing, according to the specification of this patent, depends upon the angle of inclination of the mixing drum, the composition of the sand to be processed, and the speed of the mixing drum. Also, the sand must be fed in continuously, which means that a suitable device, such as a silo with an output belt as shown in German Auslegeschrift 1,245,047 must be used, which means that the overall system is costly.

Although devices for simultaneous preparation and cooling are known, such as shown in German patent 2,015,642, a desirable arrangement is to have a cooling area series-connected with the device, such as shown in above-mentioned Auslegeschrift 1,245,047.

An object of the present invention is to avoid the aforementioned disadvantages and to provide an apparatus which is compact, technically well-controlled and uncomplicated for processing or preparing sand, and which consists of few components so that it can be produced at low cost, and which is capable of accommodating sand input which is not necessarily continuous or at a steady rate.

Briefly described, the invention includes an apparatus for processing granular material, especially foundry mold sand, having predetermined characteristics comprising the combination of a receptacle for receiving granular material to be processed, means for feeding granular material to said receptacle, mixing means in said receptacle for mixing material contained therein, discharge means forming the bottom of said receptacle for rem ving proc ss d granular material therefrom, means for monitoring th l vel r weight of materi l in said receptacle between upper and lower limits and for producing signals representative of the level or w ight variable speed drive means responsive to said signals representative f level or weight for driving said discharge means to remov material at rates select d to maintain the level or weight between said limits, means for measuring the temperature of granular material being fed to said receptacle and for producing a first control signal, first water supply means for supplying water to said receptacle in response to said first control signal and said signals representative of level, means for measuring the moisture content of granular material being fed to said receptacle and for producing a second control signal, and second water supply means for supplying water to said receptacle in response to said second control signal and said signals representative of level.

In order that the manner in which the foregoing and other objects are attained in accordance with the invention can be understood in detail, particularly advantageous embodiments thereof will be described with reference to the accompanying drawings, which form a part of this specification, and wherein:

Figure 1 is a schematic side elevation, partly in section, of an apparatus in accordance with the invention; and

Figure 2 is a partial end elevation, also partially in section, along line 2-2 of Figure 1.

As shown in the drawings, the apparatus includes a processing vessel indicated generally at 2 which comprises a receptacle open at the top which can be referred to as a homogenization receptacle or mixing chamber, the receptacle being shown in side elevation, in section, in Figure 1 and in a sectioned end elevation in Figure 2. Sand is fed to receptacle 2 by a chute 3 which fills the receptacle to a desired level or weight. A conveyor belt or other form of feed device can be used instead of chute 3. The level or weight within receptacle 2 is monitored by level or weight sensing devices 4 and 5, of a conventional type, which substantially continuously monitor the level or weight of material in the receptacle between upper and lower limits, and produce signals representative of that level or weight. As will be recognized, the fill-level means detection could alternatively be a weight measuring apparatus so that, in that event, the filling is registered by keeping track of the measurement of weight of the sand fed into the receptacle.

Within receptacle 2 is a transversally or longitudinally arranged mixing apparatus which includes a plurality of rotatably mounted shafts 9 which extend through the interior of the receptacle, substantially parallel with each other, the shafts having radially protruding mixing tools 10 mounted thereon. The mixing tools 10 rotate through overlapping circles and are axially offset from each other so that the tools 10 intermesh but do not contact each other. The bottom of vessel 2 is formed by an endless belt conveyor 13 which forms discharge means for removing processed granular material from th receptacl . As will be further described, belt 13 can be employed to remov material at various speeds.

At th upper end of the receptacl is a means for measuring the temperature of granular material being supplied to the receptacle, this means including a temperature measuring probe 14 arranged adjacent th sand input area so that it detects the temperature of the sand delivered by chute 3.

Advantageously, th temperature indicator can be an infrared probe. Also, a moisture sensing means 15 is mounted in a similar fashion. The moisture measurement can be determined by measuring the electrical resistance or capacitance of the incoming sand or, alternatively, by monitoring the power requirement of the drive apparatus for the mixing apparatus 9 10. Two water input conduits 19 19' and 20, 20' are disposed above or within receptacle 2, each of the mixing conduits having downwardly directed spray nozzles 21, the water supply means thus formed being provided to moisten the sand. As will be described, the temperature and moisture measuring devices 14, 15, which are disposed outside of the spray area of nozzles 21, control the variable water inputs independently of each other. Temperature measuring device 14 produces an electrical signal which is supplied to a converter 25 which converts the temperature measurement signal into a first control signal which is coupled to valve means 19a at the input of pipe 19 to control the water flow rate of a suitable volume of water. Similarly, moisture measuring device 15 is connected to a converter 26 which produces a second control signal for operating a valve apparatus 20a to control the rate of water flow through conduit 20.

The fill level or weight indicators produce electrical signals which are connected to a converter 27 which converts the signals from the fill level or weight indicators into a control signal for varying the rate of speed of conveyor belt 13. Belt 13 is driven by a drive means such as variable speed direct current motor 31 which receives the control signal from converter 27, the speed being controlled so that the level of material within receptacle 2 remains within the upper and lower level limits determined by the level or weight sensing devices 4 and 5. The signals from converters 25 and 26 are also passed through converters 32 and 33 which receive the level indicating signal so that the amount of water supplied by conduits 19 and 20 is also operated as a function of the level of material within the receptacle, respectively speed rate of the conveyor 13.

In receptacle 2, the quantity of sand is thoroughly mixed with the water coming from nozzles 21 by the mixing means. The sand, which is thus processed, is then fed by conveyor 13 to a separate belt conveyor 37 or, alternatively, directly into a cooling device which is thus series-connected with receptacle 2, the cooling device not being shown. The metal volume of input water is so determined that, after cooling to room temperature, the sand has a predetermined degree of moisture. The water required for subsequent evaporation is fed in dependent upon the sand flow-through volume at the instant of measurement, and the sand temperature at that instant. This arrangement has the significant advantage that the functions dependent upon th sand flow-through rate can simply b not used if th sand supply and rate f feed through the receptacle are constant.

Since the quantity of sand fed in from chute 3 can be variable, th discharge speed and therewith the quantity of discharge Q_c, which can also be influenced by a vertically movable plate 38 which adjusts the siz of a discharg opening abov belt 13, is so regulated that the fill level vari s only within a desired fill level range. With decreasing sand input, the fill level will tend to drop below the level determined by indicator 5. Converter 27 then responds by slowing the discharge speed of belt 13 until the level rises once again above the lower limit, whereupon the discharge speed and, therewith, the quantity Q_c which is discharged remain constant. On the other hand, with increasing sand input, the level of sand rises to the upper limit which, in a similar manner, causes acceleration of belt 13 until the level drops to within the desired range.

The added water volume Q_T, which is added as a function f_T of the temperature T, is now corrected in proportion to the discharged sand quantity Q_c. Further, as a function f_F of the moisture F, the added water volume Q_F is corrected in porportion to the quantity Q_c. The total added water volume Q_w is, therefore:

$$Q_w = Q_T + Q_F, \text{ wherein}$$

$$Q_T = f_T \,.\, T \,.\, f_c Q_c$$

$$Q_F = f_F F \,.\, f_c Q_c \,.$$

While certain advantageous embodiments have been chosen to illustrate the invention it will understood by those skilled in the art that various changes and modifications can be made therein without departing from scope of the invention as defined in the appended claims.

CLAIMS

1. An apparatus for processing granular material, especially foundry mold sand, having predetermined characteristics comprising the combination of

a receptacle for receiving granular material to be processed;

means for feeding granular material to said receptacle;

mixing means in said receptacle for mixing material contained therein:

discharge means forming the bottom of said receptacle for removing processed granular material therefrom;

means for monitoring the level or weight of material in said receptacle between upper and lower limits and for producing signals representative of the level;

variable speed drive means responsive to said signals representative of level for driving said discharge means to remove material at rates selected to maintain the level or weigh between said limits;

means for measuring the temperature of granular material being fed to said receptacle and for producing a first control signal;

first wat r supply means for supplying water to said receptacle in response to said first control signal and said signals repr sentative of level;

means directly or indirectly for m asuring the moisture content of granular material being fed to said receptacl and for producing a second control signal; and

second water supply means for supplying water to said receptacle in response to said second control signal and said signals representative of level.

2. An apparatus according to claim 1 wherein said discharge means comprises an endless belt conveyor.

3. An apparatus according to claim 2 wherein said receptacle includes

means defining a discharge opening in a wall of said receptacle above said belt conveyor; and

a height-adjustable plate extending across said discharge opening.

4. An apparatus according to claim 1, 2 or 3 wherein said mixing means comprises

a plurality of rotatable shafts transversally or longitudinally arranged in said receptacle; and

a plurality of mixing elements on each of said shafts, said mixing elements being axially offset to pass between elements on adjacent shafts without touching.

5. An apparatus according to claim 1, 2 or 3 wherein said means for measuring temperature comprises an infrared responsive probe.

6. An apparatus according to claim 4 wherein said mixing means includes variable speed drive.

7. An apparatus according to claim 1 wherein said means for monitoring the quantity material inludes a weighing device.

8. An apparatus according to claim 1 and substantially as hereinbefore described with reference to, and as shown in the accompanying drawing.

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